



*Synopsis: The State of South Dakota is building a radio communication system that allows radio users from all federal, state and local levels of government in South Dakota — any place, any time and with existing radio systems — to communicate in the interest of public safety. This state-of-the-art system allows radio services to follow radios anywhere in South Dakota.*

### Several Radio Frequencies in Use

State Radio had its inception in the 1940s with a lowband (39 Mhz) system consisting of a few towers that were tied together with radio (RF) links. The lowband radio frequency offered the greatest range and required the least number of stations.

In the early 1960s, a plan was drawn up and implemented for a statewide communications system interlinked by a microwave network.

The 1970s saw the development of the state Department of Transportation's VHF highband (150-170 Mhz) system. This was put in place primarily as a means for the engineering staff to have a communications system within their own organization. The highband frequencies allowed for a quieter radio operation and for the ability to "repeat" the signal, vastly extending the range vehicle to vehicle.

The forest fires in the late 1980s prompted the building of a state Division of Forestry highband system in the Black Hills. Constructed primarily for fire and emergency response, the system allows for handheld radio operation during fire fighting.

Corrections facilities also had communications come on line in the 1970s through the 1990s. The Sioux Falls correctional units were the first to get an in-house system with a UHF (450-470 Mhz) repeater system. The UHF frequency allowed for communications in a campus

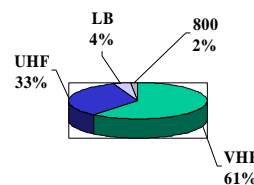
type situation. Systems at Springfield, Custer and Pierre followed.

The 1990s saw communications systems developed at some of the major park and recreation areas in the state. Lewis & Clark, Oakwood, Farm Island/West Bend and Newton Hills all have UHF systems providing portable (handheld) radio coverage.

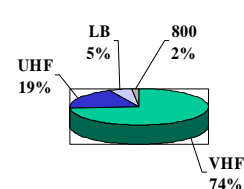
Today the state government radio infrastructure consists of 43 towers, 22 transmitter sites and a microwave interconnect system. State government uses 1,929 mobile (vehicle) radios and 618 portable (handheld) radios on lowband, highband and UHF. Local public safety agencies use more than 5,000 mobiles and 3,500 portables on lowband, highband, UHF and 800 Mhz systems. The federal government has an internal mandate to be completely on highband by 2005.

### Several Radio Frequencies in Use

**Portable Radios**



**Mobile Radios**



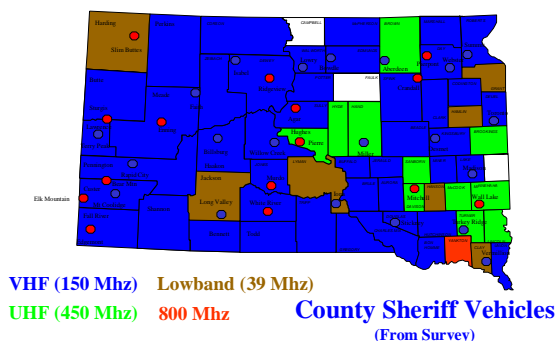
Source: BIT December 2000 Survey

## Agencies Cannot Talk When Most Needed

The lowband frequency in use from the 1940s has a number of fundamental problems. Lowband is the most prone to “skip” (radio signals bounce off atmosphere to interfere with other radio systems) and to RF interference from computers and other electronic equipment.

As other local, county, and federal agencies developed communication systems for their needs, the move was made to other frequencies such as VHF highband (150-170 Mhz), UHF (450 Mhz) and to a limited extent 800 Mhz. These frequencies offered a much cleaner signal and proved more flexible in operation. The primary problem created by these moves was an inability to talk between state organizations. For example, a snowplow operator can't talk to a highway patrolman.

## Challenging Communications



Gov. Bill Janklow saw the critical need to solve the dilemma of different agencies could not talk when needed most — whether passing on the road, during an emergency (such as the Spencer tornado) or fighting fires (such as the Jasper fire).

## Legislature Took Action in 1999

The South Dakota Legislature in the 1999 session approved House Bill 1292, which was signed by the governor into law. It directed eight State agencies to integrate their telecommunications functions and facilities into a single cohesive network. An

Internet link to South Dakota Codified Law 34-45-33 appears under the additional resources section of this issue brief.

## Governor Janklow Found Funding

A \$7,000,000 COPS grant from the U.S. Department of Justice, a \$4,000,000 appropriation from the 2001 legislative session, another \$3,991,200 COPS grant, a \$1,110,700 Highway Safety grant and \$1,129,974 in state agency funding allowed Gov. Janklow to begin the process of creating a modern radio system that will be available to all levels of government. These funds are being used to buy the radio system infrastructure, mobile and portable radios for state government agencies and mobile radios for local public safety agencies. Radios will be given out based on the December 2000 survey results.

## Motorola's VHF Solution Best for SD

After a lengthy evaluation process, a Motorola VHF (150 Mhz) digital trunked system was chosen as the best fit for South Dakota based upon the following criteria:

- ❑ Compatible with 73% of existing local mobiles in the state and all federal users.
- ❑ Direct compatibility with federal users — meets Federal 2005 mandate to be on VHF.
- ❑ No usage fees for local agency use.
- ❑ Many radio dealers in state.
- ❑ Uses existing state and federal facilities (towers, buildings, etc.).

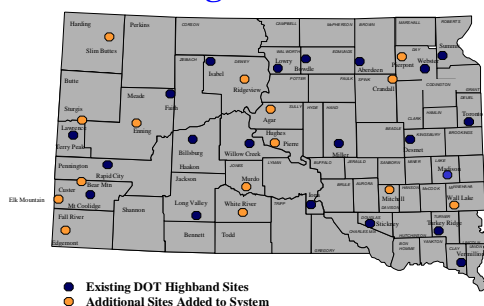
## One Frequency Ensures Interoperability

The state's radio system solution allows existing analog VHF users to communicate day one — at a minimum through the statewide mutual aid channel. All proposed radios can utilize any VHF system — whether new, existing, analog or digital. Ultimately, using one frequency ensures radio communications anywhere in South

Dakota. Additionally, VHF allows the easiest, less costly path of local agency migration into the digital world.

For those operating on UHF (450 Mhz) or 800 Mhz, the state will use cross-band repeaters to allow access to the mutual aid channel in their area. The local agency has the responsibility to install and maintain the repeater equipment.

## Single Frequency Statewide VHF – Highband – 150 Mhz

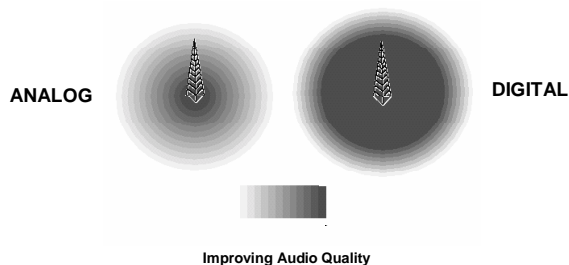


Digital radios convert spoken voice into a stream of data bits, which is sent over the air on a radio wave. Analog radios convert spoken voice into a modified frequency format which is sent over radio waves.

Digital radios outperform analog radios by offering superior voice quality, signal range and security. Since the digital radio actually is a computer, the radio can “digitally” fill in missing or garbled transmissions, thereby extending the radio’s range of clear signals. Digital audio provides a more constant level of quality audio — the dark area in the diagram below:

## DIGITAL VOICE QUALITY

- Digital offers superior system-wide audio



The system allows state and local radio users to transmit data in addition to their normal voice communications. Now maps, fingerprints and other data will flow to the state’s public safety officials in the field.

A trunked system was chosen. A trunked radio system allows many users to share a limited number of radio channels by utilizing the first available channel for each conversation. By not having dedicated channels, a trunked radio system allows the radio to “hop” from channel to channel to find an open path, thus more efficiently using the channels at a site. The trunked technology allows:

- More efficient use of radio channels, thereby lowering system costs;
- Communications with anyone, anywhere in the state — from mobile users to portable users to dispatchers;
- Complete autonomy for each talk group (a predefined group of radio users who can privately communicate with each other). Radio service can be made to follow the radio anywhere in the state;
- Enhanced system management to ensure high availability, reliability and serviceability; and
- Bridging from analog to digital technology. New radios can access old systems while old radios can access the new system through Mutual Aid.

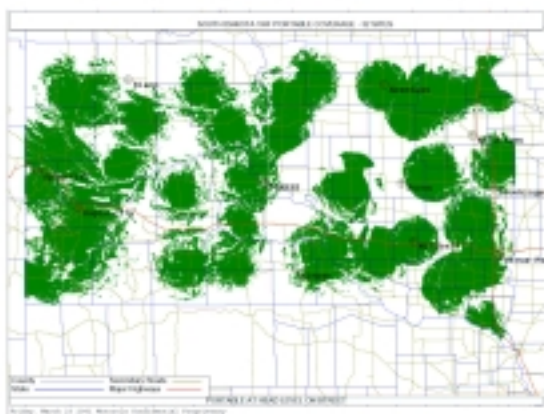
The communities in South Dakota benefit with a VHF digital, trunked network by getting improved federal-state-local communications, improved emergency response, standardized communications, modern communications facilities and data communications.

### **Radio System Coverage Best It Can Be**

The state's radio system guarantees mobile coverage as shown in the diagram below:



Portable coverage is never as extensive as mobile coverage but the state has engineered extensive coverage in the Black Hills and major population centers:



### **Digital Radios Act Like Computers**

A trunked radio is basically a computer with a receiver and transmitter attached. Digital radios send and receive voice and data digitally — sending 1s and 0s through the air rather than analog audio waves. Digital radios convert the signals back to analog to play over the speaker. Each radio has a digital address much the same as a computer on a network. This address identifies the radio to the central network controller, which then directs a given

transmission to those users listening to a particular talk group. Radios can search across talk groups and the radio user can easily switch between the primary talk group and any other talk group, such as the statewide Mutual Aid channel.

The mobile/portable radios for use on this system will also accommodate all conventional (non-trunked) VHF channels. This allows communications on both old and new radio systems with a single radio, thereby allowing local agencies relatively easy migration from their older conventional systems. All radios are “data ready” and APCO 25 compliant (the federal government’s standard), operate in the federally mandated narrowband (12.5 Mhz) and have built-in security features.

### **Radio System Works Like Telephone System**

In a trunked radio system, there are no dedicated channels for any one user. The channels at all sites are available for use by all users and are linked together by a control computer located in Pierre. As the microphone push-to-talk (PTT) button is depressed, an open channel is selected and a communications path is set up between those users in the talk group. This eliminates the need to wait for an open channel (as is the case on a dedicated repeater) and allows for a much more efficient use of the frequency.

With all radio sites (at various towers) across the state linked together through the central controller in Pierre, radio users have access to the system anywhere in the state. Radio users can communicate across the state simply by speaking into the microphone, just like the public telephone system.

The state has engineered its radio sites to have a minimum of four trunked channels. One is used for control purposes (to run the system), leaving three channels for handling radio calls. A trunked channel can support between 75-100 radio users.



Keep in mind the average radio conversation is between 5-10 seconds. With three radio channels available at 180 seconds per minute, the likelihood of conversations bumping into each other are slim, even if a large number of users are under way.) If traffic on the radio system exceeds capacity, then the state will add channels at the problem sites.

In addition to the trunked channels, there will be an overlay of "mutual aid" channels. These are conventional VHF channels that are slated to be placed at 35 sites statewide. These channels will allow anyone with an older conventional VHF radio to communicate with those on the new system. These channels are conventional repeaters and will operate only in the coverage area of those repeaters — not across the state. All state radios will be equipped with these frequencies. State Radio dispatch will monitor these channels around the clock.

A data channel, in addition to the channels mentioned above, will also be placed at each site. This is a dedicated data channel that will allow the use of mobile data terminals (MDTs) by law-enforcement or other agencies. The data speed will be at 9600 bits per second.

For those still operating on the low-band government channel (39.10), the channel will be supported at most of the present sites it is no longer used by local agencies.

### **State Will Maintain A State-of-the-Art Radio System**

The radio system and network will be supported by the State of South Dakota via the Bureau of Information and Telecommunications' (BIT) State Radio group. The State will maintain the towers, repeater equipment, central controller and transport equipment. Local users will be responsible for maintenance and repair of the mobiles and portables in use by those agencies and any related control equipment (console/dispatch) used.

### **Talk Groups Keep You In Touch With Home**

Agency groupings (talk groups) will be established with the cooperation of local users. These talk groups will allow private conversations within that talk group, similar to that of a dedicated channel. The system will be "fleet-mapped" to connect the members of a talk group regardless of their location within the state. Multiple talk groups (up to 256) can be programmed into the radios and can be scanned between groups.

The development of talk groups will require input from the agencies using the system. Talk groups can be added or modified at a later date but the State can be much more efficient if it's done at the start. The primary issue is determining whether the new system is going to be utilized now or in the future as the primary communication system for the agency. If the system is going to be the secondary system, a more regional approach for that agency would be the most practical.

For larger departments whose communications are largely within their immediate group of radio users, a talk group will probably be required for that group. For agencies whose communications are with another department (such as a local police department, sheriff's office, fire department, etc.) a regional talk group may be more practical.

### **New Radios Can Be Used on Existing Radio Systems**

The radios being utilized for the system are capable of talking on both existing analog systems and the new trunked system. The State is asking local agencies for an accurate channel plan of their current radios. The channel plan will be programmed in their new radios prior to shipment.

### **Phased System Implementation**

The radio system infrastructure is scheduled to be implemented in phases — starting with the Black Hills/western South Dakota region, followed by eastern South Dakota and finally the central part of the state. Coordination of the system programming for the mobile units will be done as the radio system infrastructure is brought on-line. Because the new digital radios will work on the existing conventional radio systems, many of these new digital radios will be in use prior to the radio system coming on-line. State personnel and contracted private dealers will reprogram radios in the field and give operating instructions.

### **Implementation Schedule Aggressive**

Infrastructure equipment at 38 sites is scheduled to be installed by November 2001. Transmitters are to be turned on in the Black Hills, Aberdeen, Chamberlain, Pierre, Rapid City, and Sioux Falls by January 2002. The rest of the implementation is scheduled to be completed and the entire system made operational by April 2002.

### **State and Locals Can Make Radio System Succeed**

What the state needs from the local agency is:

- ❑ Provide the channel plan one wishes to have programmed into agency radios.
- ❑ Identify local, district and regional communications needs. This drives the development of agency talk groups.
- ❑ Follow grant process to request EF Johnson mobile radios — found to have necessary software, channel count and radio features at the least cost.

- ❑ Participate in the radio system.
- ❑ Consider offering your local assets (towers or frequencies) to the state system — such as Marshall County and Bon-Homme County did.

### **Easier, Least Costly Migration Path**

With the majority of local radio users in the state operating on VHF, access to the state system is gained by simply programming the mutual aid channel into their current radios. The mutual aid channel will allow communications with all state users and dispatch centers. This allows the local entity to phase in new digital radios on their own schedule. Besides working on local agency systems, these new radios offer more capabilities on the state system.

For those operating on UHF (450 Mhz) or 800 Mhz, the State is prepared to offer a cross-band repeater to those users that will allow access to the mutual aid channel in their area. The system operator has the responsibility to install and maintain the repeater equipment.

Lowband (39 Mhz) users will continue to have a government (39.1) station available in their area to access State Radio (SRC) dispatch.

Dispatch centers have many options:

- ❑ An inexpensive VHF control station connected to the dispatch equipment will allow access to the local mutual aid channel.
- ❑ Digital trunked control stations can be connected to console equipment that will allow access to particular talk groups. Initial state dispatch talk groups alignment is around tower sites (geographical), allowing a local dispatch center to monitor dispatch related traffic only in their area. An example would be the Mitchell SRC talk group. Davison County would only need a single control station to monitor all traffic to and from the SRC dispatch center within the+

county. Additional coverage areas could be added as needed.

- ❑ A digital trunked base can be set up in the center that allows access to ALL authorized talk groups.
- ❑ A direct connection to the central controller can be established. This allows backup of any connected site by any other connected site. This option requires particular dispatch equipment, and a transport to the master site in Pierre.

### **Additional Resources**

A slide presentation of Governor Janklow's speech summarizing the state radio communications plan can be found on the Internet:

<http://www.state.sd.us/governor/press/speeches/2001/vhfradio/>

South Dakota Codified Law 34-45-33 is available via the Internet:

<http://legis.state.sd.us/statutes/Index.cfm?FuseAction=DisplayStatute&FindType=Statute&txtStatute=34-45-33>

An explanation of Motorola trunking concepts can be found on the Internet:

[http://www.motorola-wls.com/CW\\_ACS002/cbt/course.htm](http://www.motorola-wls.com/CW_ACS002/cbt/course.htm)

For information on the Johnson 5300 mobile radio: <http://www.efjohnson.com>

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